Remarks

Applicants believe that this amendment places the subject application in better condition for allowance and in so doing introduces no new issues. Therefore, entry of this Amendment, reconsideration of the application, and allowance of all claims pending herein is respectfully requested.

Claims 1-15 were originally presented in the subject application. The Office Action stated that "Claims 1-15 are generally narrative and indefinite, failing to conform with current U.S. practice. They appear to be a literal translation into English from a foreign document and are replete with grammatical and idiomatic errors." (Office Action p.3 ¶ 5). In response, claims 1-15 have been amended to more particularly point out and distinctly claim the subject matter that Applicants regard as their invention, and to conform with current U.S. practice. Claims 1-15 remain in this case.

The Examiner's concerns are addressed separately below in the order raised in the outstanding Office Action. No new matter has been added.

Rejections under 35 U.S.C. §112

Claims 1-15 stand objected-to, and rejected, for failing to particularly point out and distinctly claim what Applicants consider to be their invention. As discussed above, Applicants have amended the claims for clarity and conformity to U.S. practice. For the convenience of the Examiner, a non-marked up copy of the amended claims is attached as an appendix.

Applicants therefore respectfully submit that the claims as amended particularly point out and distinctly claim the present invention and that accordingly, this ground of rejection should be withdrawn.

Rejections under 35 U.S.C. §102

Claims 1-8 and 10-14 stand rejected under 35 U.S.C. § 102 as anticipated by Mikio, JP 2000-020501. Applicant respectfully traverses this rejection for the reasons set forth below.

Mikio employs a different approach for sorting data. Mikio requires that, as a starting point, there must be 2^n processing units. In some instances, if there are not 2^n processing units,

then dummy processing units, without data, are added until the amount of data is 2^n. For example, if there are $2^n + 1$ processing units, then $2^n - 1$ dummy processing units, without data, are added.

In contrast, the claimed invention does not require the use of dummy units, and therefore operates at a higher level of efficiency. In the claimed invention, each data exchange actively involves all of the processors (if the number of processors is even), or all of the processors but one (if the number of processors is odd).

1) Mikio only works for numbers of processing units in an exponential power of 2.

Mikio repeatedly states in the disclosure that the data to be processed must be processed by 2^n processing units. If the number of processing units is not in the form of 2^n, then Mikio requires either that dummy units (with no data to be processed) are added until the total number of units are in the form of 2^n, or that the existing numbers of processing units are divided into subgroups, each subgroup having 2^n processing units.

The Mikio disclosure provided by the Office appears to be a direct (e.g. machine) translation from the Japanese. Therefore, some of the following quotes may be grammatically incorrect and awkwardly phrased.

Mikio Figs. 1 and 2

In Mikio Fig. 1, there are 8 processing units (designated by the reference numbers 2-1 to 2-8). This means there are 2^3 processing units. In Fig. 2, there are also 8, or 2^3 processing units, designated as PE-0 through PE-7.

Mikio Fig. 5

Mikio Fig. 5 apparently refers to 6 processors designated as PE0-PE5. Since 6 is not an exponential value of 2, two dummy processors with no data are added, (designated as PE6 and PE7), so that the total number of processors will be 8, which is an exponential value of 2, i.e., 2^3. "[T]he arrangement of parallel calculation is divided into six, for example, and the case where it assigns six sets (an identification number is set to 0, 1, -- 5) of processing units is explained." (Mikio p. 17 ¶ 0046). "Suppose that two sets … of processing units other than six sets [previously described PE0-PE5] of said processing units are used for data processing in this

case." (Mikio p.18 ¶0046).

Mikio appears to confirm that dummy processors PE6 and PE7 have no data. "Processing unit 6 (110) [and] processing unit 7 (111) Since there is no data which should be exchanged, it stops. At this time 2^n data is brought together in the processing units 0-5." (Mikio p.18 ¶ 0047). Mikio repeats that dummy processing unit 6 has no data. "For example, processing unit 4 (100) [and] processing unit 6 (110). Although [units 4 and 6 are to perform] a data exchange, it is the processing unit 6 (110) at this time. Since there is no data which should be transmitted, only suppose that it is to receive data from the processing unit 4." (Mikio p. 18 ¶ 0048).

Mikio Fig. 6

Mikio Fig. 6 shows 6 processing units, designated as PE0-PE5. Since 6 is not an exponential power of 2, the processing units are divided into groups that correspond to powers of 2. In this case, the 6 units are divided into a group of 4 units (2^2) and a group of 2 (2^1) units.

Mikio describes Fig. 6, where there are 6 processors, designated as PE0 - PE5. "First, six sets of processing units are divided into two groups. The processing unit group 1 consists of four sets of the identification numbers 0-3. The processing unit group 2 consists of two sets of the identification numbers 4-5." (Mikio p. 19 ¶ 0055). Fig. 6 reveals that the group 2, containing 2^1 units, is idle for the first step.

Mikio Fig. 7

In Mikio Fig. 7, there are 10 processing units. Since 10 is not an exponential power of 2, it is necessary to divide the 10 units into subgoups of 8 units (2^3) and 2 units (2^1). "First, ten sets of processing units are divided into two groups. The processing unit group 1 consists of eight sets of the identification numbers 0, 1, -- 7. [PE0 - PE7]. The processing unit group 2 consists of two sets of the identification numbers 8 and 9." (Mikio p. 20 ¶ 0058). Fig. 7 indicates that the group of 2 units is idle for the first 2 steps.

Mikio Fig. 8

In Mikio Figs. 8 and 9, there are 22 processing units, designated as PE0-PE21. Since the Mikio approach only works for powers of 2, it is necessary to divide the 22 processing units into subunits. In Fig. 8, the PEs have been divided into 16 units (2^4), 4 units (2^2), and 2 units (2^1). In

other words, the 20 units were divided into units of $2^4 + 2^2 + 2^1$.

Mikio describes the situation in drawing 8, where 22 sets (designated as PE0 - PE21) are divided into 16, (e.g., 2^4) + 4 (e.g., 2^2) + 2 (e.g., 2^1) sets.

> [A] processing unit is first divided into the following three groups.
>
> Group 1: Processing unit of the identification numbers 0, 1, --, 15 (16 sets) [PE0 - PE15]
>
> Group 2: Processing unit of the identification numbers 16, 17, 18 and 19 (four sets) [PE 16 - PE19]
>
> Group 3: Processing unit of the identification numbers 20 and 21 (two sets) [PE20 - PE 21]

(Mikio p. 20-21, ¶ 0062).

Mikio appears to confirm that the groups of processing units which are not in the form of 2^n may be reformed into groups in the amounts of 2^n, and processed in the same way as the previously described 8, i.e., 2^3 processing units. "The same operation effect as the 1st embodiment of the above can be acquired by having composition which applied correspondingly by this also to the processing unit of the number which is not the exponential of 2 in the case of the exponential of 2." (Mikio p. 18 ¶ 0049).

Mikio 12 units example

Mikio provides another example of adding dummy processor units with no data, so that the total number of processors is an exponential value of 2. "For example, arrangement which consists of 12 elements (3,1,4,1,5,9,2,6,5,3,5,8) Arrangement which will consist of four elements if it is (0,0,0,0) Arrangement which adds and consists of an element of 16 (3,1,4,1,5,9,2,6,5,3,5,8,0,0,0,0) It carries out." (Mikio p.18 ¶ 0051).

Mikio further explains how a number of processing units which are not a power of 2 can be processed as if they were a power of 2. "The form of the 2nd and 3rd operation is 2^{n+1} about the case where it is divided into an individual when the number of partitions of [an] arrangement is not the power of 2 (2^{n+k}). How to concentrate a data array to one piece with the processing unit of a stand is described. On the other hand, the number of partitions of arrangement processes the form of this operation with the processing unit of a stand ($2^n + 2^m$) to the case where it is $2^n + 2^m$ (n>m)." (Mikio p. 19 ¶ 0053).

2) Mikio leaves more than one processing unit idle during the data exchange steps.

The Mikio drawings show that more than one processing unit lays idle during the data processing. For example, in Fig. 5, PE-6 and PE-7 are idle for the first step. In Mikio Fig. 7, PE-8 and PE-9 are idle for two steps.

In some instances, it appears that nearly half of the Mikio processor units are dummy units without data. It is Applicants' understanding that in a case of $2^n + 1$ processing units, data transmission is carried out by the addition of $2^n - 1$ dummy processing units without data. For example, if n = 4, then $2^n+1 = 2^4+1 = 16+1 = 17$ processor units. The number of dummy units would be $2^n-1 = 2^4-1= 16-1 = 15$ dummy processor units. The total number of units would be 32, e.g., 2^5, which is the required 2^n amount. However, 15 out of the 32 processor units are dummy units, meaning that only 17/32 units exchange data, at a data transfer efficiency rate of 53%. In other words, since nearly half of the processors are dummy units, the system operates at only approximately 50% efficiency.

On the other hand, the present invention optimizes efficiency of data transmission. When the number of processor units is even, all of the processors are used for the exchange of data, at a data transmission efficiency of 100%. When the number of processor units is odd, all of the processor units except one are used. For example, if there are 21 processor units, then 20 units would be used for each step to transmit data. The efficiency of data transmission would therefore be 20/21 = 95%. Therefore, the efficiency of data transmission is nearly 100%.

3) The claimed invention subdivides the data for any number of processing units

The below is an example of data distribution according to Mikio and the present invention in the case of eight processing units. The Mikio data is represented as the following at the start of the process.

Mikio:

**********START**********

PE0={a(0), 0, 0, 0, 0, 0, 0, 0}

PE1={ 0,a(1), 0, 0, 0, 0, 0, 0}

PE2={ 0, 0,a(2), 0, 0, 0, 0, 0}

PE3={ 0, 0, 0,a(3), 0, 0, 0, 0}

PE4={ 0, 0, 0, 0,a(4), 0, 0, 0}

PE5={ 0, 0, 0, 0, 0,a(5), 0, 0}

PE6={ 0, 0, 0, 0, 0, 0,a(6), 0}

PE7={ 0, 0, 0, 0, 0, 0, 0,a(7)}

****

At the end of the process, each original data unit is divided among each processing unit, as shown.

**********END**********

PE0={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE1={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE2={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE3={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE4={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE5={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE6={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE7={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

****

In contrast, embodiments of the present invention call for subdividing the units of data into eight sections per processor, and then redistributing these units of data among the processors.

The subdivided data, before the data exchange among processors, is as follows.

The present invention:

**********START**********

PE0={a(0),a(1),a(2),a(3),a(4),a(5),a(6),a(7)}

PE1={b(0),b(1),b(2),b(3),b(4),b(5),b(6),b(7)}

PE2={c(0),c(1),c(2),c(3),c(4),c(5),c(6),c(7)}

PE3={d(0),d(1),d(2),d(3),d(4),d(5),d(6),d(7)}

PE4={e(0),e(1),e(2),e(3),e(4),e(5),e(6),e(7)}

PE5={f(0),f(1),f(2),f(3),f(4),f(5),f(6),f(7)}

PE6={g(0),g(1),g(2),g(3),g(4),g(5),g(6),g(7)}

PE7={h(0),h(1),h(2),h(3),h(4),h(5),h(6),h(7)}

****

A unit of subdivided data from each processor is transmitted to the appropriate processor. For example, all units of data designated as (0), regardless of their original locations, are transferred to PC0.

**********END**********

PE0={a(0),b(0),c(0),d(0),e(0),f(0),g(0),h(0)}

PE1={a(1),b(1),c(1),d(1),e(1),f(1),g(1),h(1)}

PE2={a(2),b(2),c(2),d(2),e(2),f(2),g(2),h(2)}

PE3={a(3),b(3),c(3),d(3),e(3),f(3),g(3),h(3)}

PE4={a(4),b(4),c(4),d(4),e(4),f(4),g(4),h(4)}

PE5={a(5),b(5),c(5),d(5),e(5),f(5),g(5),h(5)}

PE6={a(6),b(6),c(6),d(6),e(6),f(6),g(6),h(6)}

PE7={a(7),b(7),c(7),d(7),e(7),f(7),g(7),h(7)}

****

Since Mikio does not disclose the claimed method of subdivision and exchange of data

among the processor units, it does not anticipate the rejected claims.

Rejections under 35 U.S.C. §103:

Claims 9 and 15 stand rejected under § 103 as unpatentable over Mikio, JP 2000-020501 in view of Official Notice. This rejection is respectfully traversed.

As discussed above, the claimed invention takes a different approach than that of Mikio. The claimed invention subdivides data for more efficient redistribution to a set number of processors. In contrast, Mikio is based on always having 2^n processors. Where the given number of processors is not equal to an exponential power of 2, then dummy processors are added, or the processors are divided into subgroups, with units equal to an exponential power of 2.

Mikio offers no suggestion of the claimed system for subdividing and distributing data. It would therefore not have been obvious to reconfigure the Mikio disclosure to produce the claimed invention, which may be used efficiently with various numbers of processors which are not exponential powers of 2.

CONCLUSION

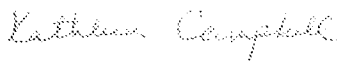
For at least any one of the foregoing alternate reasons, Applicants submit that the dependent claims are allowable for the same reasons as the independent claims from which they directly or ultimately depend, as well as for their additional limitations. Applicants therefore further submit that all of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot.

This application is now believed to be in condition for allowance, and such action at an early date is respectfully requested. However, if any matters remain unresolved, the Examiner is encouraged to contact the undersigned by telephone.

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, Applicants petition for any required relief including extensions of time and authorizes the Assistant Commissioner to

charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 50-0734** referencing Docket No. 1215.004. However, the Assistant Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Respectfully submitted,



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